Finite Elements In Fluid

Unsteady convection and convection-diffusion problems

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Exercise on pure convection

1.Compute the Courant number.

$$C = \frac{A\Delta T}{H}$$
=0.75

- Solve the problem using the Crank-Nicholson scheme in time and linear finite element for the Galerkin scheme in space. Is the solution accurate?

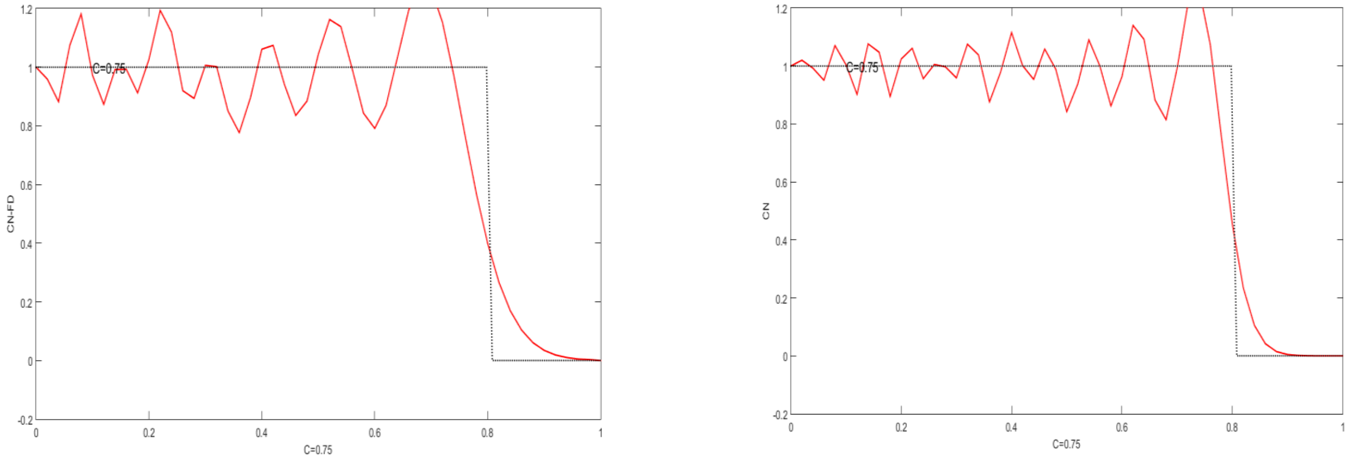


Figure 1 Lumped and consistent mass Crank Nicolson scheme

With C=0.75 the above results are achieved. By crank Nicolson , residual oscillation are remained in the front. These could be removed using nonlinear viscosity. The results achieved, we can say that the consistent mass matrix have better accuracy than the lumped mass system

- Solve the problem using the second-order Lax-Wendroff method. Can we expect the solution to be accurate? If not, what changes are necessary? Comment the results.

As solved by C=0.75 the results are plotted below.
Lax-Wendroff method which is based on truncated Taylor series expansion is used here . We can say that the results of the consistent mass method are better than the lumpd mass method and our theory is satisfy with the graphs below.

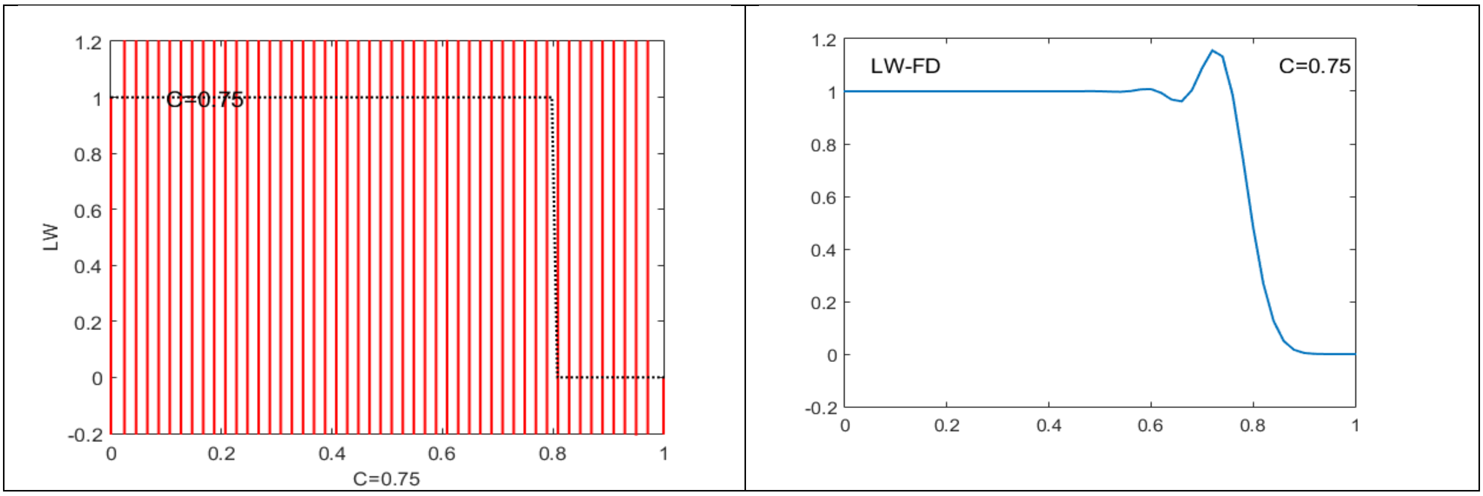
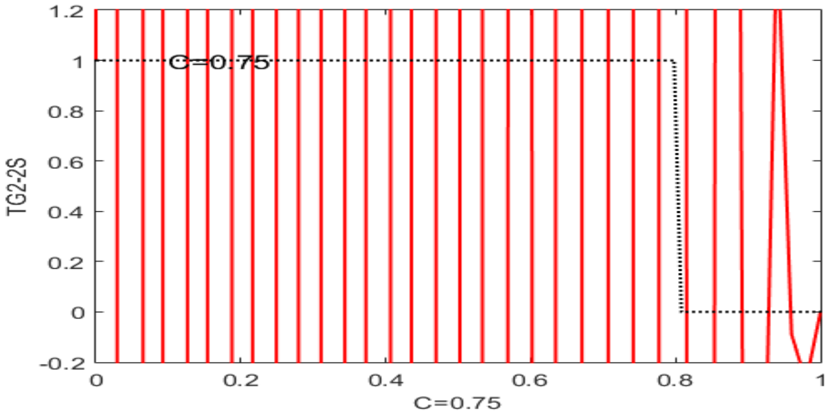


Figure 2 Lax-Wendroff consistent and lumped mass

- Implement the second-order two-step Lax-Wendroff method.
  Comment the results.



The computaion is done at C=0.75. The stability for this method is found upto C=0.30 and we get the same result, which are unstablethere is vast oscilations we can see in the results.